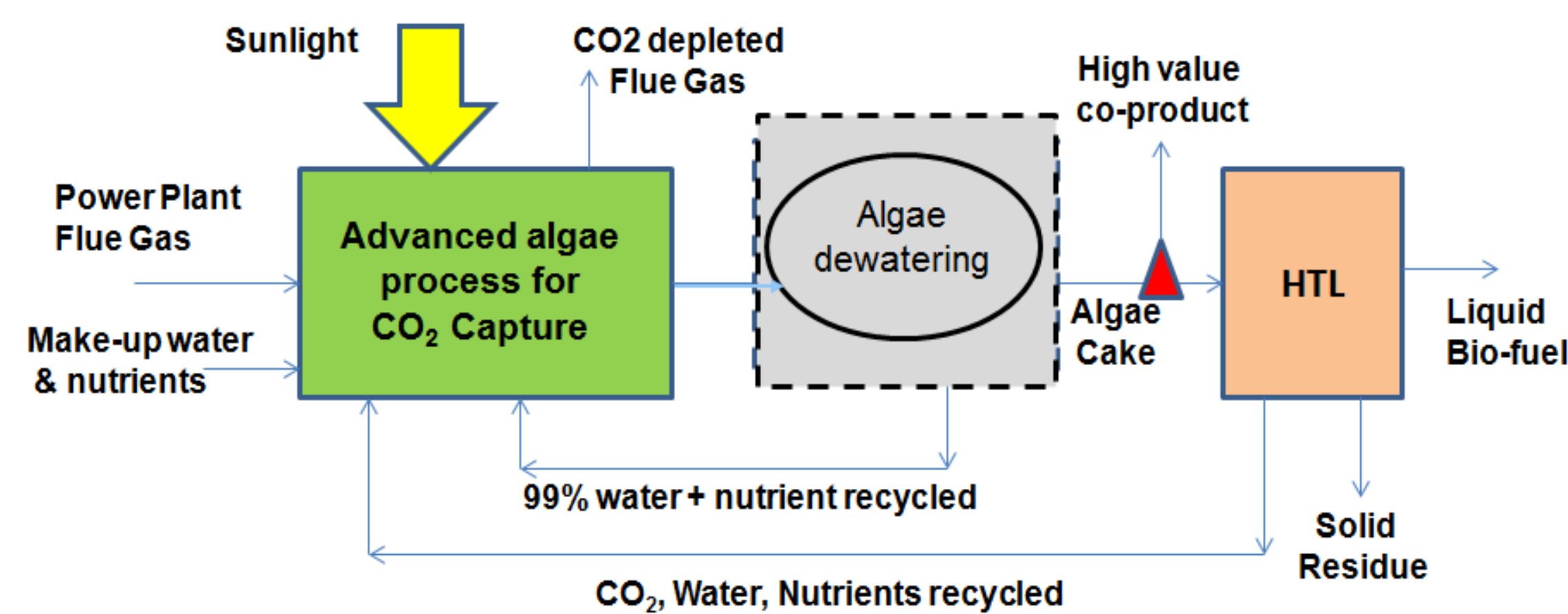


Project Overview

Overall Objective

1. Develop a novel algae technology for efficient CO₂ capture from coal power plant flue gas
2. Make bio-fuels & other products from algae to mitigate the cost of carbon capture

Strategy

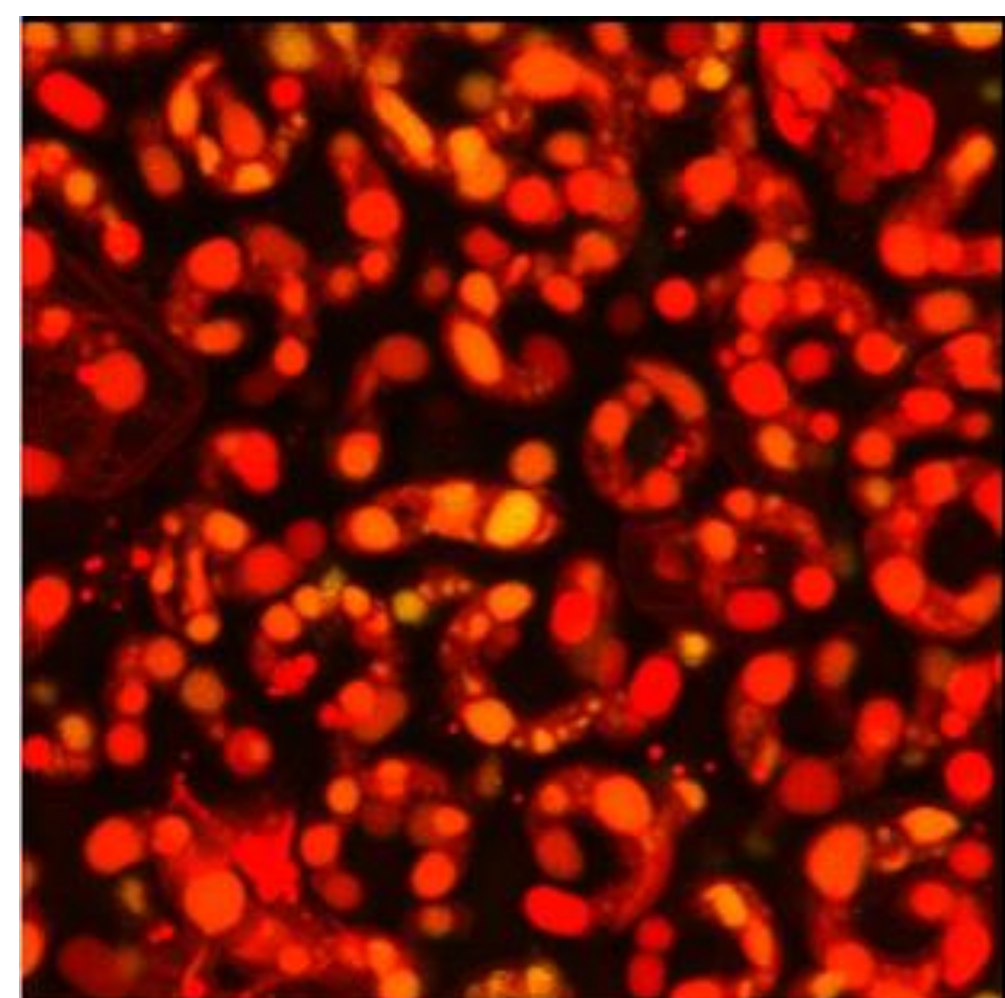


1. Utilize micro-algae to metabolize and capture CO₂
2. Enable high CO₂ capture efficiency and productivity
3. De-water the algae at low energy & cost
4. Recycle water & nutrients to minimize consumption
5. Convert the algae to fuel via HTL process
6. Extract high value co-products

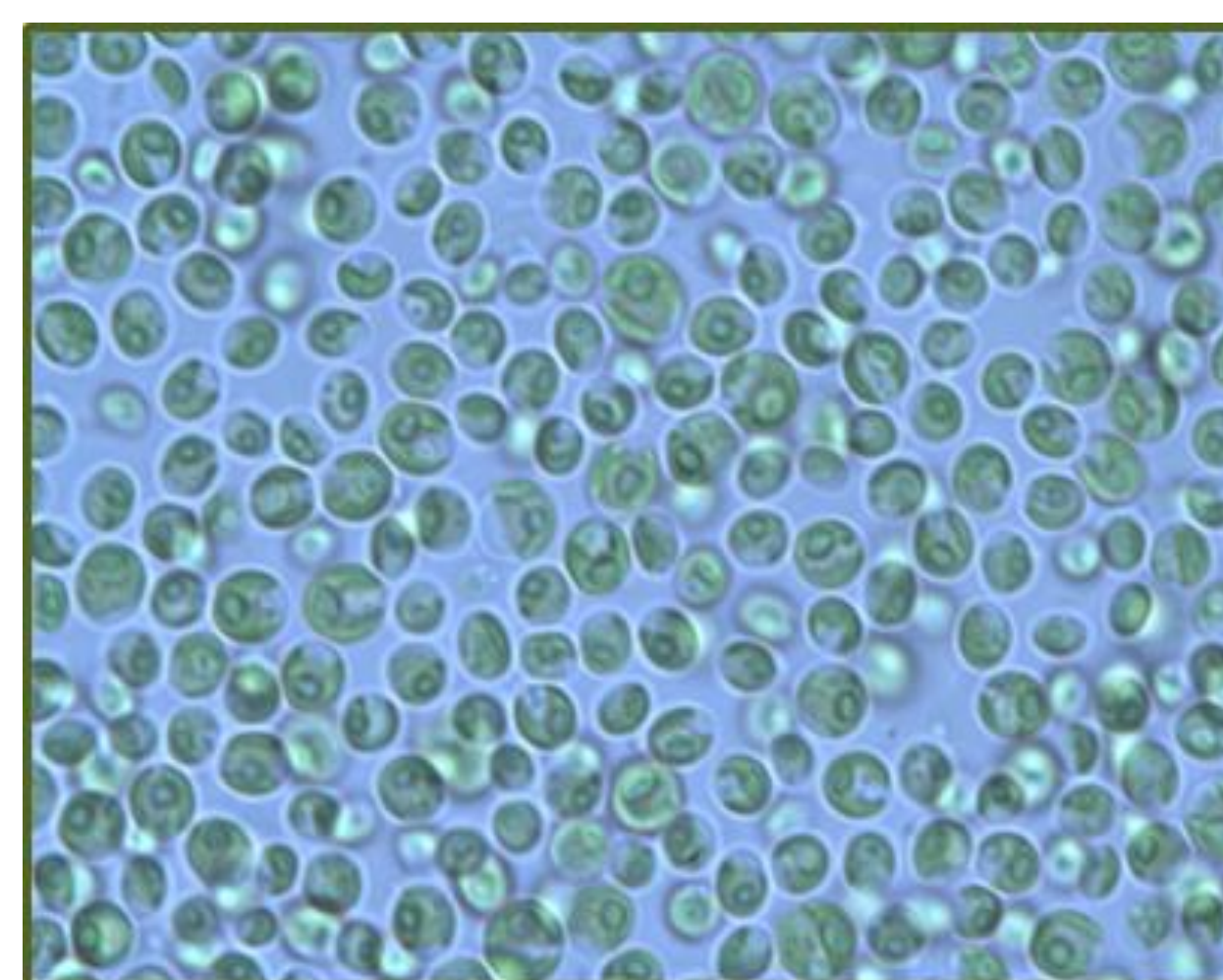
Challenges in Algae CO₂ Capture

1. Complex living system – prediction difficult
2. 12% CO₂ is 300x of ambient
3. Impact of SO_x and NO_x unknown
4. Growth rate & capture efficiency often inversely related
5. Achieving 90% CO₂ capture efficiency is difficult
6. All downstream applications require dewatering

Microalgae Strains

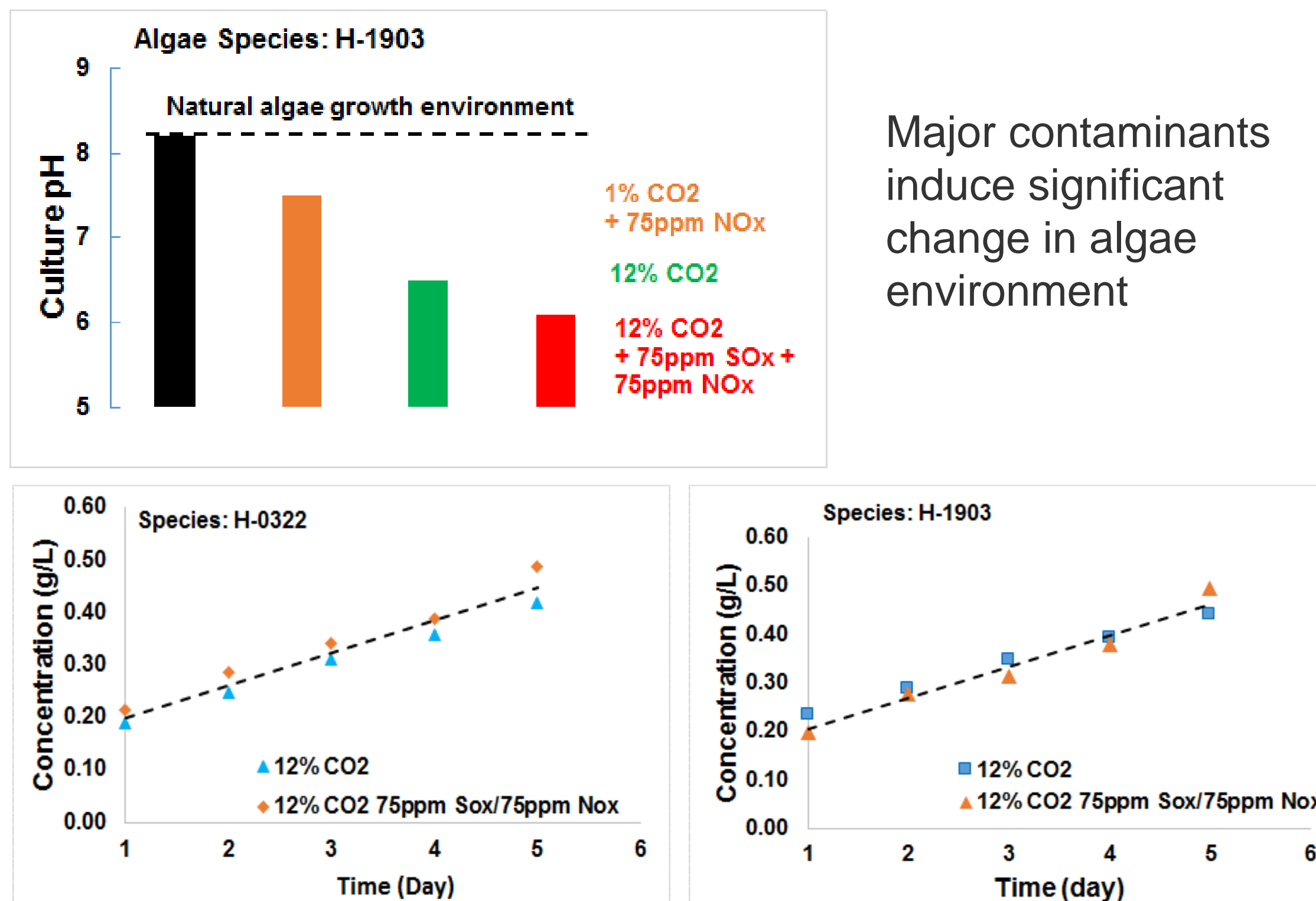


H-1903



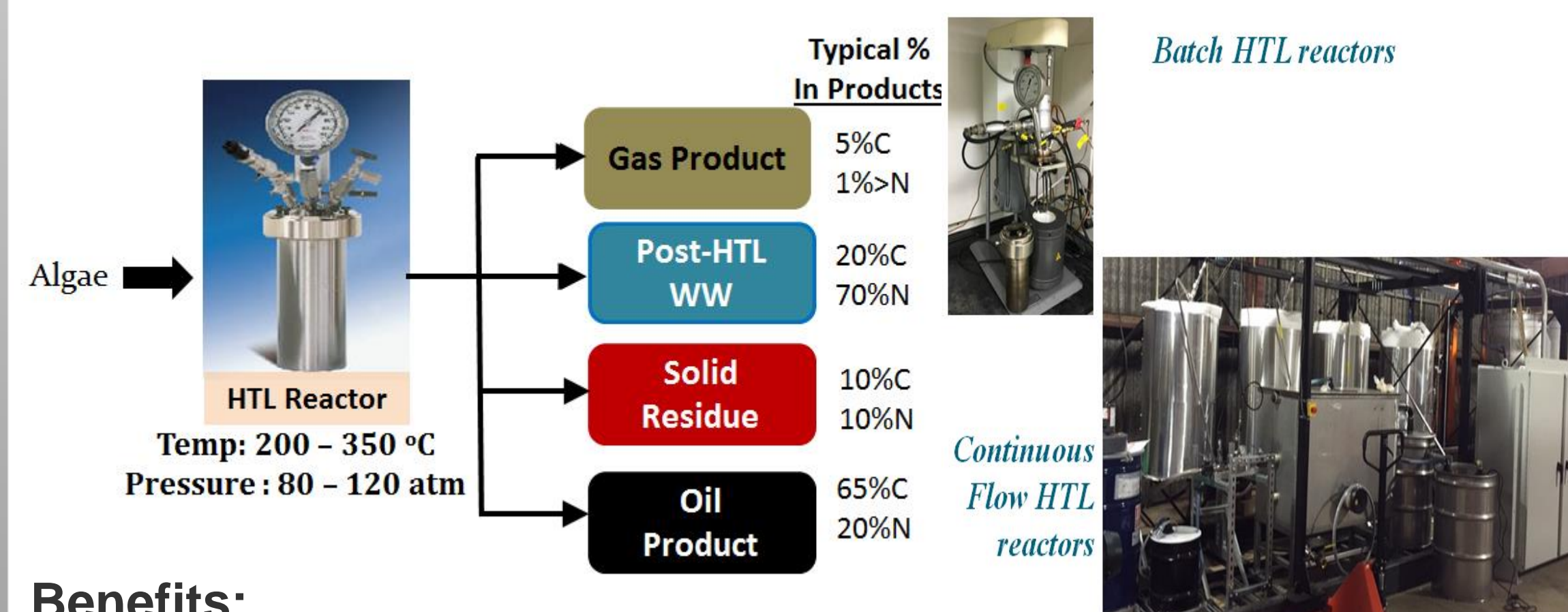
H-0322

Algae Survival in Template Post FGD gas



Stable algae growth demonstrated for H-0322 and H-1903 at 12% CO₂ + 75ppm SO_x + 75ppm NO_x

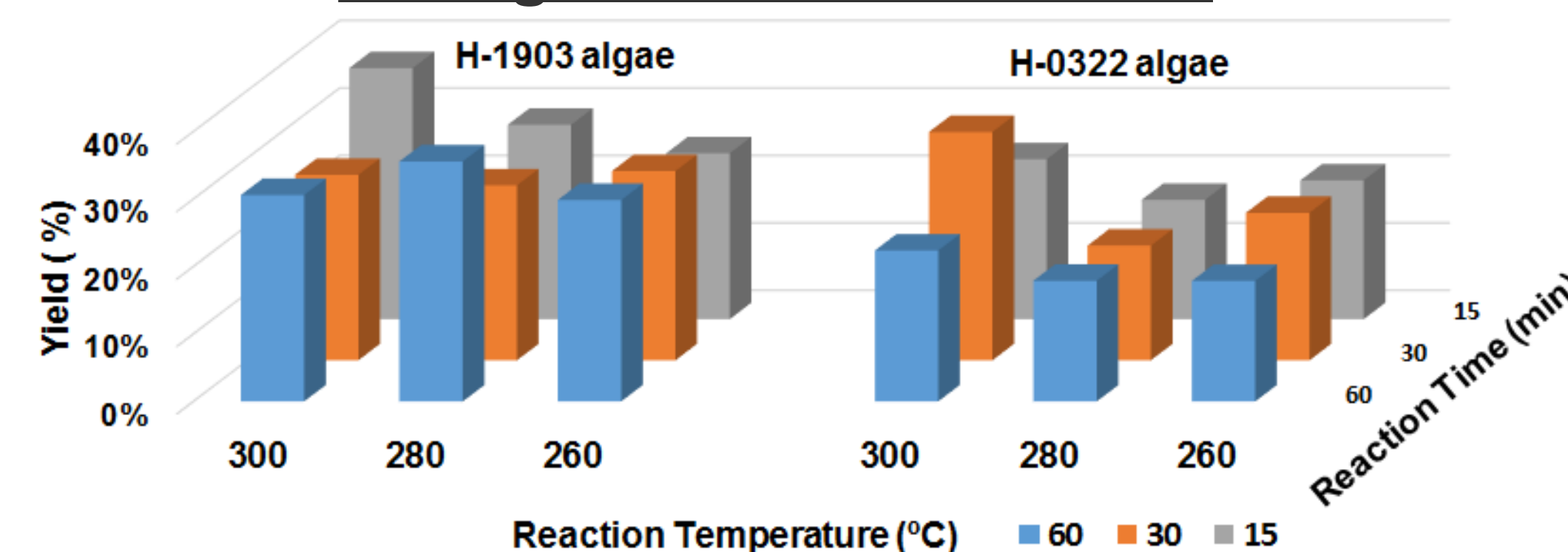
Hydrothermal Liquefaction (HTL) of Algae



Benefits:

1. Can process wet biomass including slurry (~20 wt% solid)
2. Produces liquid bio-crude -easily used in existing infrastructure
3. High biomass utilization
4. No catalyst needed
5. Most nutrients remain in solution & can be recycled to algae
6. Favorable Economic & Energy Balances Projected
 - Diesel cost from HTL = \$1.54/gal + feed cost (DOE-BETO)

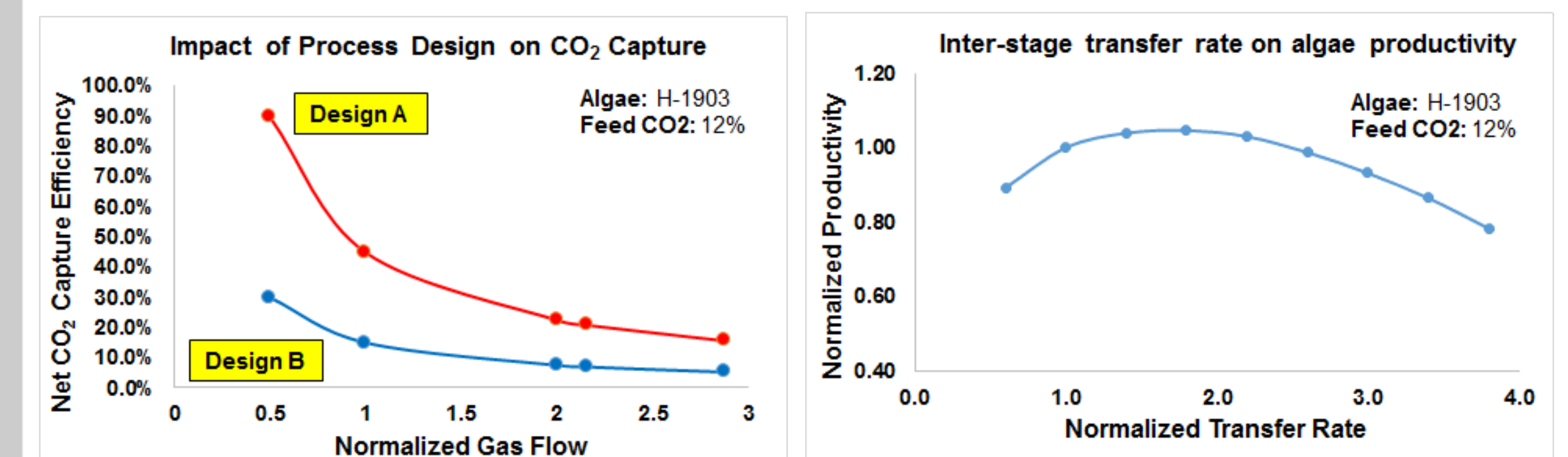
Average Oil Conversion Yield



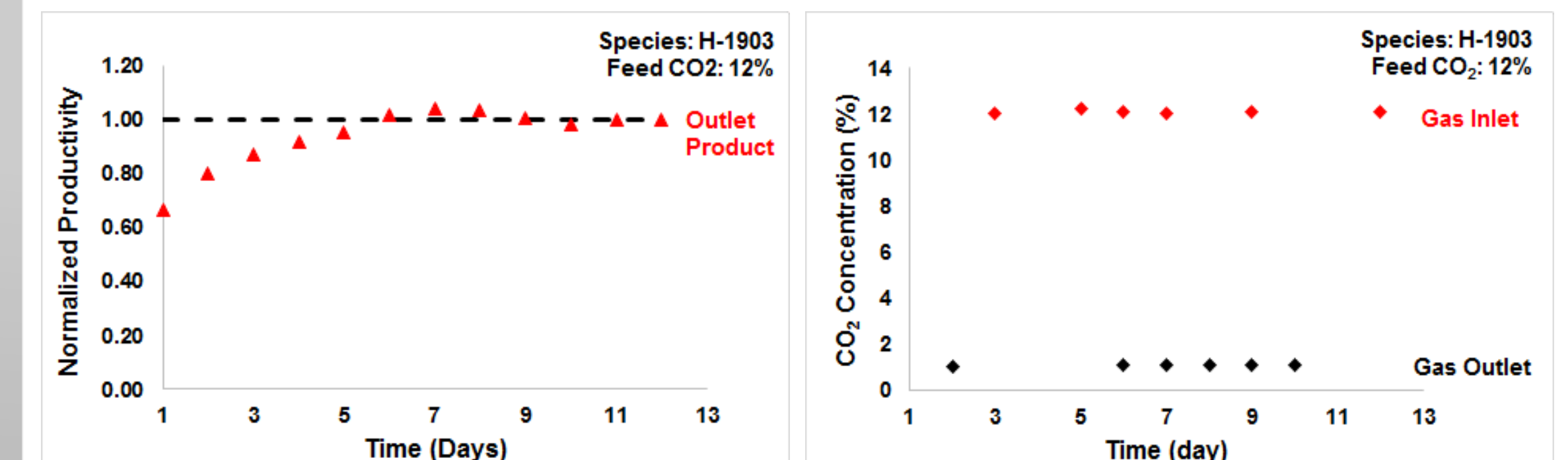
Advanced Algae Process for CO₂ Capture

1. Continuous process
2. 90% CO₂ capture efficiency achievable
3. Design of each stage remains optimal over time
4. Enables stable capture efficiency with time
5. High productivity
6. Suitable for integrating with upstream/downstream processes

Model Simulation



Experimental Results



• Stable algae concentration and CO₂ capture efficiency demonstrated
 • High overall CO₂ capture efficiency achieved

Conclusions

- Survival & growth of two algae species validated in simulated flue gas
- >80% CO₂ capture efficiency demonstrated
- Good HTL conversion of algae to bio-crude demonstrated
- Co-product generation economically valuable
- Preliminary economic assessment shows potential for CO₂ capture cost <\$30/ton

Acknowledgement

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